

A RUSSIAN ANALEMMATIC DIAL

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Shelkovo is a small town near Moscow. The river Kliazma flows steady through it. A few years ago, Dmitry Barchenkov, a businessman from the town, concluded that the shores of this river should be improved as they did not match his ideas for the town development. Last year he built a very nice embankment along the riverside but was not satisfied with the result. It needed something unique and inviting that nobody had ever seen in this country.

I proposed to make an analemmatic sundial. I thought that nothing would be more unusual than an analemmatic sundial installed into the paving of the embankment and it became clear that this was the right idea. This article describes the way my friends and I made this sundial.

First of all, I made a drawing for coordinates $55^{\circ} 55.504' N$; $37^{\circ} 59.813' E$. I used the algorithm of Carl Sabanski published in the Internet.¹ By means of AutoCAD™, I drew the scale of dates and the ellipse with hour marks for standard time and for daylight saving time. AutoCAD is a very useful program for designing sundials. By using parametric designs, it produces high resolution pictures for showing to Council members who do not need mathematic details but who are responsible for the city's architectural appearance. During the period of discussion, the main difficulty was to come to an agreement with the customer about the inscription on the information board. We wasted a great deal of time trying to choose the best one. Finally the inscription "Know the time and refrain from evil" was accepted. It is a quotation from a medieval Christian philosopher, Jesus the Salach's son.

Making The Casting Models

Models may be made of any material. We made them of plaster-of-Paris (gypsum). We filled moulding boxes, specially made of plywood, with the gypsum mixture. Then, when it had set hard, we carved out the figures and the parts of the scale of dates with ordinary chisels (Fig. 1).

The next step was to turn the gypsum models into beeswax copies. We made wooden boxes, put the gypsum models into them (face up) and filled the box with silastic (silicone?). This produced a silastic 3D mirror reflection of the model. Then we filled this silastic reflection with molted beeswax into which some aniline dye was added to show up blobs, scratches and imperfections clearly (Fig. 2). To each wax piece we welded a small wax funnel and one



Fig. 1. Sculptor Sergey Seriozhin shows the figure '20' that he just has carved. It is a precursor of the bronze numeral for the dial.

of two wax rods; the tip of the funnel cone and the end of rods being attached to the same edge of the detail. The former is a filling port for the molted bronze, the latter serves as an air hole.

Making the Ceramic Mould for Casting

We prepared a mixture containing, by weight, 60% of dry gypsum and 40 % of fireclay powder. Little by little we added water to this mixture and agitated it with a stirrer until a creamy consistency was achieved. We coated each wax piece carefully with this cream, put them into wooden boxes (the funnels and air holes are on the tops of the pieces) and filled the boxes up with the rest of the mixture.



Fig. 2. Sculptor Victor Ardyniev demonstrates a wax model of part of the date scale.



Fig. 3. The casting process. A relaxed looking gentlemen in the background is in fact the main personage – sculptor Sergey.

Twenty-four hours later we put the boxes into a furnace and left them there until the melted wax had flowed out completely.

Casting and Finishing

We cast the details in Sergey's studio. It is well equipped but the capacity of the smelting furnace is rather small at 15 litres. We could have placed an order for casting in a larger foundry but we thought that it was a matter of honour to make everything with our own hands. So we had to repeat the melting process (Fig. 3) more than once. The 'bronze' used was actually a leaded gunmetal (85% Cu; 5% Zn; 5% Sn; 5% Pb), selected on cost grounds.

The pieces coming from the moulds looked very unattractive. They were covered with ridges resulting from cracks in the moulds produced by the high temperatures. We removed these ridges with sandpaper and polished the surfaces with abrasive paste.

The thickness of the bronze plates is about 10 mm. This means that any criminally-minded person could break an installed piece off with a simple crowbar. To complicate the 'work' of such persons, we welded bronze rings to the backs of the pieces, put 15 mm diameter steel reinforcement bars through them, and cast reinforced concrete plates around them. Thus the resulting weight of the dial numerals and the date scale had risen from 50 kg to 300 kg. Six strong and healthy workers could hardly carry the scale of dates (Fig. 4). So let vandals just try.

Building the Foundations

While we were carrying out our studio experiments, workers had divided off the elliptical area of the embankment paving and excavated the foundation trench. The bottom of the trench was at a depth of 1 metre. They put in a 60 cm thick layer of sand with, above it, a layer of crushed stone (15 cm) and then poured a 15 cm thick concrete raft. They



Fig. 4 (top). The date scale weighs about 300 kg.

Fig. 5 (centre). Reinforcing the concrete foundation.

Fig. 6 (bottom). Stone paving in the rain.

reinforced the raft with a mesh of steel bars 15 mm in diameter. A home of average size might be safely built on such foundations (Fig. 5). The reliability of this design leads us to hope that the sundial will not be in need of repair for at least a few centuries.

Installation

We had very fine weather for all the preliminary work. But it was spoiled just the day we started the installation. Downpours alternated with thunderstorms and prevented us from laying the granite setts onto the makeup cement-sand pad. Our building yard had turned into a sort of morass and there was a danger for all of us to get bogged down in it

(Fig. 6). It was already June 17. A grand opening ceremony set the deadline on the summer solstice. Mrs Ershova, the Head of City Administration, came to see us twice a day to insist that we should finish the work on time at all costs as the cosmonauts, popular actors, a brass band, local clergy, leaders of local political parties and other honorable guests, including the rest of the city population, were already invited and must not be disappointed. Dmitry Barchrnkov, the main sponsor and one of the authors, saved the situation. In a few hours, a team of his house-builders built a complete cover over our building yard. It was made of corrugated steel and was supplied with roof, door and even windows.



Fig. 7. Rubble infill of the information plate stand.

A particular matter was to make a basement for the inscription plate. We made it of granite slabs forming a kind of prism with a rubble-work infill. The jointed edges of the granite parts were carefully adjusted to each other. The joints were invisible to the naked eye (Fig. 7). So we hope that algae and other micro-organisms never settle and destroy them. The final result is shown in Figs. 8 and 9.



Fig. 8. A general view of the final result.



Fig. 9. The inscription plate.

The Great Opening

Everything that the Head of City Administration told us became a gospel truth. There was a brass band, passionate speeches, honourable guests, girls' choral singing, and even anthems. The only thing missing was the sun: the day brought foggy cold weather. But who we are to grumble about this?

Two months later I happened to meet Mrs Ershova again. The window of her office opens onto the embankment just opposite the sundial. She told me that, according to her observations, the most inquisitive citizens of the town of Shelkovo try to use our sundial even at night. I feel that something is right here.

A detailed photo report can be found at:
<http://www.sundials.ru/shelkovo-mounting.html>.

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REFERENCE

1. Carl Sabanski's website 'The Sundial Primer' is at www.mysundial.ca/